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Kant's Doctrine of the A Priori in the Light of Contemporary Biology ~

For Kant, the categories of space, time, causality, etc., are givens established a priori, determining the form of all of our experience, and indeed making experience possible. For Kant, the validity of these primary principles of reason is absolute. This validity is fundamentally independent of the laws of the real nature which lies behind appearances. This validity is not to be thought of as arising from these laws. The a priori categories and forms of intuition cannot be related to the laws inherent in the "thing-in-itself" by abstraction or any other means.¹ The only thing we can assert about the thing-in-itself, according to Kant, is the reality of its existence. The relationship that exists between it and the form in which it affects our senses and appears in our world of experience is, for Kant, alogical (to somewhat overstate it). For Kant, the thing-in-itself is in principle unknowable, because the form of its appearance is determined by the purely ideal forms and categories of intuition, so that its appearance has no connection with its essence. This is the viewpoint of Kantian "transcendental" or "critical" idealism, restated in a condensed version.

Kant's orientation has been transformed very liberally by various natural philosophers. In particular, the ever more urgent questionings of the theory of evolution have led to conceptions of the a priori which are perhaps not so far removed from those of Kant himself as from those of the Kantian philosopher tied to the exact terms of Kant's definition of his concepts.

The biologist convinced of the fact of the great creative events of evolution asks of Kant these questions: Is not human reason with all its categories and forms of intuition something that has organically evolved in a continuous cause-effect relationship with the laws of the immediate nature, just as has the human brain?

Would not the laws of reason necessary for a priori thought be entirely different if they had undergone an entirely different historical mode of origin, and if consequently we had been equipped with an entirely different kind of central nervous system? Is it at all probable that the laws of our cognitive apparatus should be disconnected with those of the real external world? Can an organ that has evolved in the process of a continuous coping with the laws of nature have remained so uninfluenced that the theory of appearances can be pursued independently of the existence of the thing-in-itself, as if the two were totally independent of each other? In answering these questions the biologist takes a sharply circumscribed point of view. The exposition of this point of view is the subject of the present paper. We are not just concerned with special discussions of space, time, and causality. The latter are for our study simply examples of the Kantian theory of the a priori, and are treated incidentally to our comparison of the views of the a priori taken by transcendental idealism and the biologist.

It is the duty of the natural scientist to attempt a natural explanation before he contents himself with drawing upon factors extraneous to nature. This is an important duty for the psychologist who has to cope with the fact that something like Kant's a priori forms of thought do exist. One familiar with the innate modes of reaction of subhuman organisms can readily hypothesize that the a priori is due to hereditary differentiations of the central nervous system which have become characteristic of the species, producing hereditary dispositions to think in certain forms. One must realize that this conception of the "a priori" as an organ means the destruction of the concept: something that has evolved in evolutionary adaptation to the laws of the natural

external world has evolved *a posteriori* in a certain sense, even if in a way entirely different from that of abstraction or deduction from previous experience. The functional similarities which have led many researchers to Lamarckian views about the origin of hereditary modes of reaction from previous "species experience" today are recognized as completely misleading.

The essential character of the natural sciences of today signifies such an abandonment of transcendental idealism that a rift has developed between the scientist and the Kantian philosopher. The rift is caused by the fundamental change of the concepts of the thing-in-itself and the transcendental, a change which results from the redefinition of the concept of the *a priori*. If the "*a priori*" apparatus of possible experience with all its forms of intuition and categories is not something immutably determined by factors extraneous to nature but rather something that mirrors the natural laws in contact with which it has evolved in the closest reciprocal interaction, then the boundaries of the transcendental begin to shift. Many aspects of the thing-in-itself which completely escape being experienced by our present-day apparatus of thought and perception may lie within the boundaries of possible experience in the near future, geologically speaking. Many of those aspects which today are within the sphere of the imminent may have still been beyond these boundaries in the recent past of mankind. It is obvious that the question of the extent to which the absolutely existent can be experienced by one *particular* organism has not the slightest influence on the fundamental question. However, such consideration alters something in the definition which we have to make of the thing-in-itself behind the phenomena. For Kant (who in all his speculations took into consideration only mature civilized man, representing an immutable system created by God) no obstacle presented itself to defining the thing-in-itself as basically unrecognizable. In his static way of looking at it, he could include the limit of possible experience in the definition of the thing-in-itself. This limit would be the same

for man and amoeba—infinitely far from the thing-in-itself. In view of the indubitable fact of evolution this is no longer tenable. Even if we recognize that the absolutely existent will never be completely knowable (even for the highest imaginable living beings there will be a limit set by the necessity of categorical forms of thought), the boundary separating the experienceable from the transcendental must vary for each individual type of organism. The location of the boundary has to be investigated separately for each type of organism. It would mean an unjustifiable anthropomorphism to include the purely accidental present-day location of this boundary for the human species in the definition of the thing-in-itself. If, in spite of the indubitable evolutionary modifiability of our apparatus of experience one nevertheless wanted to continue to define the thing-in-itself as that which is unrecognizable for this very apparatus, the definition of the absolute would thereby be held to be relative, obviously an absurdity. Rather, every natural science urgently needs a concept of the absolutely real which is as little anthropomorphic and as independent as possible of the accidental, present-day location of the limits of the humanly experienceable. The absolutely actual can in no way be a matter of the degree to which it is reflected in the brain of a human, or any other temporary form. On the other hand, it is the object of a most important branch of comparative science to investigate the type of this reflection, and to find out the extent to which it is in the form of crudely simplifying symbols which are only superficially analogous or to what extent it reproduces details, i.e., how far its exactness goes. By this investigation of prehuman forms of knowledge we hope to gain clues to the mode of functioning and historical origin of our own knowledge, and in this manner to push ahead the critique of knowledge further than was possible without such comparisons.

I assert that nearly all natural scientists of today, at least all biologists, consciously or unconsciously assume in their daily work a real relationship between the thing-in-itself and the phenomena of our subjective experi-

ence, but a relationship that is by no means a "purely" ideal one in the Kantian sense. I even would like to assert that Kant himself assumed this in all the results of his own empirical research. In our opinion, the real relationship between the thing-in-itself and the specific a priori form of its appearance has been determined by the fact that the form of appearance has developed as an adaptation to the laws of the thing-in-itself in the coping negotiation with these continuously present laws during the evolutionary history of mankind, lasting hundreds of millennia. This adaptation has provided our thought with an innate structuralization which corresponds to a considerable degree to the reality of the external world. "Adaptation" is a word already loaded with meaning and easily misunderstood. It should not, in the present condition, denote more than that our forms of intuition and categories "fit" to that which really exists in the manner in which our foot fits the floor or the fin of the fish suits the water. The a priori which determines the forms of appearance of the real things of our world is, in short, an organ, or more precisely the functioning of an organ. We come closer to understanding the a priori if we confront it with the questions asked of everything organic: "What for," "where from," and "why." These questions are, first, how does it preserve the species; second, what is its genealogical origin; third, what natural causes make it possible? We are convinced that the a priori is based on central nervous systems which are entirely as real as the things of the external world whose phenomenal form they determine for us. This central nervous apparatus does not prescribe the laws of nature any more than the hoof of the horse prescribes the form of the ground. Just as the hoof of the horse, this central nervous apparatus stumbles over unforeseen changes in its task. But just as the hoof of the horse is adapted to the ground of the steppe which it copes with, so our central nervous apparatus for organizing the image of the world is adapted to the real world with which man has to cope. Just like any organ, this apparatus has attained its expedient species-preserving

form through this coping of real with the real during its genealogical evolution, lasting many eons.

Our view of the origin of the "a priori" (an origin which in a certain sense is "a posteriori") answers very fittingly Kant's question as to whether the forms of perception of space and time, which we do not derive from experience (as Kant, contrary to Hume, emphasizes quite correctly) but which are a priori in our representation "were not mere chimeras of the brain made by us to which no object corresponds, at least not adequately."² If we conceive our intellect as the function of an organ (and there is no valid argument against this), our obvious answer to the question why its form of function is adapted to the real world is simply the following: Our categories and forms of perception, fixed prior to individual experience, are adapted to the external world for exactly the same reasons as the hoof of the horse is already adapted to the ground of the steppe before the horse is born and the fin of the fish is adapted to the water before the fish hatches. No sensible person believes that in any of these cases the form of the organ "prescribes" its properties to the object. To everyone it is self-evident that water possesses its properties independently of whether the fins of the fish are biologically adapted to these properties or not. Quite evidently some properties of the thing-in-itself which is at the bottom of the phenomenon "water" have led to the specific form of adaptation of the fins which have been evolved independently of one another by fishes, reptiles, birds, mammals, cephalopods, snails, crayfish, arrow worms, etc. It is obviously the properties of water that have prescribed to these different organisms the corresponding form and function of their organ of locomotion. But when reckoning in regard to structure and mode of function of his own brain, the transcendental philosopher assumes something fundamentally different. In paragraph 11 of the Prolegomena, Kant says: "If anyone were to have the slightest doubt that both (the forms of intuition of space and time) are not determinations of the thing-in-itself but mere determinations of

their relation to sensibility, I should like to know how it could be found possible to know a priori and thus prior to all acquaintance with things, namely before they are given to us, what their intuition must be like, which is the case here with space and time."³ This question clarifies two very important facts. First, it shows that Kant, no more than Hume, thought of the possibility of a formal adaptation between thought and reality other than through abstracting from previous experience. Second, it shows that he assumed the impossibility of any different form of origin. Furthermore, it shows the great and fundamentally new discovery of Kant, i.e., that human thought and perception have certain functional structures prior to every individual experience.

Most certainly Hume was wrong when he wanted to derive all that is a priori from that which the senses supply to experience, just as wrong as Wundt or Helmholtz, who simply explain it as an abstraction from preceding experience. Adaptation of the a priori to the real world has no more originated from "experience" than has adaptation of the fin of the fish to the properties of water. Just as the form of the fin is given a priori, prior to any individual coping of the young fish with the water, and just as it is this form that makes possible this coping: so is it also the case with our forms of perception and categories in their relationship to our coping with the real external world by means of experience. For animals there are specific limitations to the forms of experience which are possible. We believe we can demonstrate the closest functional and probably genetic relationship between these animal a priori's and our human a priori.

Contrary to Hume, we believe as did Kant in the possibility of a "pure" science of the innate forms of human thought independent of all experience. This "pure" science, however, would be able to convey only a very one-sided understanding of the essence of a priori forms of thought because it neglects the organic nature of these structures and does not pose the basic biological question concerning their species-preserving meaning. Bluntly speak-

ing, it is just as if someone wanted to write a "pure" theory on the characteristics of a modern photographic camera, a Leica for example, without taking into consideration that this is an apparatus for photographing the external world, and without consulting the pictures the camera produces which enable one to understand its function and the essential meaning of its existence. As far as the produced pictures (just as experiences) are concerned, the Leica is entirely a priori. It exists prior to and independently of every picture; indeed, it determines the form of the pictures, nay, makes them possible in the first place. Now I assert: To separate "pure Leicology" from the theory of the pictures it produces is just as meaningless as to separate the theory of the a priori from the theory of the external world, of phenomenology from the theory of the thing-in-itself. All the lawfulnesses of our intellect which we find to be there a priori are not freaks of nature. We live off them! And we can get insight into their essential meaning only if we take into consideration their function. Just as the Leica could not originate without the activity of photography, carried out long before the Leica was constructed, just as the completed Leica with all its incredibly well-conceived and "fitting" constructional details has not dropped from the heavens, so neither has our infinitely more wonderful "pure reason." This, too, has arrived at its relative perfection from out of its activity, from its negotiation with the thing-in-itself.

Although for the transcendental idealist the relationship between the thing-in-itself and its appearance is extraneous to nature and alogical, it is entirely real for us. It is certain that not only does the thing-in-itself "affect" our receptors, but also vice versa, our effectors on their part affect" absolute reality. The word "actually" comes from the verb "to act." (Wirklichkeit kommt von Wirker!) What appears in our world is by no means only our experience one-sidedly influenced by real external things as they work on us as through the lenses of the ideal possibilities of experience. What we witness as experience is always a coping of the real in us with the real outside

of us. Therefore, the relationship between the events in and outside of us is not alogical and does not basically prohibit drawing conclusions about the lawfulness of the external world from the lawfulness of the internal events. Rather, this relationship is the one which exists between image and object, between a simplified model and the real thing. It is the relationship of an analogy of greater or less remoteness. The degree of this analogy is fundamentally open to comparative investigation. That is, it is possible to make statements as to whether agreement between appearance and actuality is more exact or less exact in comparing one human being to another, or one living organism to another.

On these premises also depends the self-evident fact that there are more and less correct judgments about the external world. The relationship between the world of phenomena and things-in-themselves is thus not fixed once-and-for-all by ideal laws of form which are extraneous to nature and in principle inaccessible to investigation. Neither do the judgments made on the basis of these "necessities of thought" have an independent and absolute validity. Rather, all our forms of intuition and categories are thoroughly natural. Like every other organ, they are evolutionary developed receptacles for the reception and retroactive utilization of those lawful consequences of the thing-in-itself with which we have to cope if we want to remain alive and preserve our species. The special form of these organic receptacles has the properties of the thing-in-itself a relationship grown entirely out of real natural connections. The organic receptacles are adapted to these properties in a manner that has a practical biological sufficiency, but which is by no means absolute nor even so precise that one could say their form equals that of the thing-in-itself. Even if we as natural scientists are in a certain sense naïve realists, we still do not take the appearance for the thing-in-itself nor the experienced reality for the absolutely existent. Thus, we are not surprised to find the laws of "pure reason" entangled in the most serious contradictions not only with one another, but also with the em-

pirical facts whenever research demands greater precision. This happens particularly where physics and chemistry enter the nuclear phase. There, not only does the intuition-form of space-perception break down, but also the categories of causality, or substantiality, and in a certain sense even quantity (even though quantity otherwise appears to have the most unconditional validity except for the intuition-form of time-perception). "Necessary for thought" in no way means "absolutely valid" in view of these empirical facts, highly essential in nuclear physics, quantum mechanics, and wave theory.

The realization that all laws of "pure reason" are based on highly physical or mechanical structures of the human central nervous system which have developed through many eons like any other organ, on the one hand shakes our confidence in the laws of pure reason and on the other hand substantially raises our confidence in them. Kant's statement that the laws of pure reason have absolute validity, nay, that every imaginable rational being, even if it were an angel, must obey the same laws of thought, appears as an anthropocentric presumption. Surely the "keyboard" provided by the forms of intuition and categories—Kant himself calls it that—is something definitely located on the physicostructural side of the psychophysical unity of the human organism. The forms of intuition and categories relate to the "freedom" of the mind (if there is such a thing) as physical structures are usually related to the possible degrees of freedom of the psychic, namely by both supporting and restraining at the same time. But surely these clumsy categorical boxes into which we have to pack our external world 'in order to be able to spell them as experiences' (Kant) can claim no autonomous and absolute validity whatsoever. This is certain for us the moment we conceive them as evolutionary adaptations—and I would indeed like to know what scientific argument could be brought against this conception. At the same time, however, the nature of their adaptation shows that the categorical forms of intuition and categories have proved themselves as working hypotheses in

the coping of our species with the absolute reality of the environment (in spite of their validity being only approximate and relative). This is clarified by the paradoxical fact that the laws of "pure reason" which break down at every step in modern theoretical science nonetheless have stood (and still stand) the test in the practical biological matters of the struggle for the preservation of the species.

The "dots" produced by the coarse "screens" used in the reproductions of photographs in our daily papers are satisfactory representations when looked at superficially, but cannot stand closer inspection with a magnifying glass. So, too, the reproductions of the world by our forms of intuition and categories break down as soon as they are required to give a somewhat closer representation of their objects, as is the case in wave mechanics and nuclear physics. All the knowledge an individual can wrest from the empirical reality of the "physical world-picture" is essentially only a working hypothesis. And as far as their species-preserving function goes, all those innate structures of the mind which we call "a priori" are likewise only working hypotheses. Nothing is absolute except that which hides in and behind the phenomena. Nothing that our brain can think has absolute a priori validity in the true sense of the word, not even mathematics with all its laws. The laws of mathematics are but an organ for the quantification of external things, and what is more, an organ exceedingly important for man's life, without which he never could play his role in dominating the earth, and which thus has amply proved itself biologically, as have all the other "pure" mathematics is not only possible, it is, as a theory of the internal laws of this miraculous organ of quantification, of an importance that can hardly be overestimated. But this does not justify us in making it absolute. Counting and mathematical numbers affect reality in approximately the same manner as do a dredging-machine and its shovels. Regarded statistically, in a large number of individual cases each shovel dredges up roughly

the same amount but actually not even two can ever have exactly the same content. The pure mathematical equation is a tautology: I state that if my dredging-machine brings in such and such a number of shovels, then such and such a number are brought in. Two shovels of my machine are absolutely equal to each other because strictly speaking it is the same shovel each time, namely the number one. But only the empty sentence always has this validity. Two shovels filled with something or other are never equal to each other, the number one applied to a real object will never find its equal in the whole universe. It is true that two plus two equals four, but two apples, rams, or atoms plus two more never equal four others because no equal apples, rams, or atoms exist. In this sense we arrive at the paradoxical fact that the equation two plus two equals four in its application to real units, such as apples or atoms, has a much smaller degree of approximation to reality than the equation two million plus two million equal four million because the individual dissimilarities of the counted units level out statistically in the case of a large number. Regarded as a working hypothesis or as a functional organ, the form of thought of numerical quantification is and remains one of the most miraculous apparatuses that nature has ever created; it evokes the admiration of the biologist, particularly by the incredible breadth of its sphere of application even if one does not consider its sphere of validity absolute.

It would be entirely conceivable to imagine a rational being that does not quantify by means of the mathematical number (that does not use 1, 2, 3, 4, 5, the number of individuals approximately equal among themselves, such as rams, atoms, or milestones, to mark the quantity at hand) but grasps these immediately in some other way. Instead of quantifying water by the number of the filled liter vessels, one could, for example, conclude from the tension of a rubber balloon of a certain size how much water it contains. It can very well be purely coincidental, in other words brought about by purely historical causes, that our brain happens to be able to quantify ex-

tensive quantities more readily than intensive ones. It is by no means a necessity of thought and it would be entirely conceivable that the ability to quantify intensively according to the method indicated by the example of measuring the tension in the rubber balloon could be developed up to the point where it would become equally valuable and replace numerical mathematics. Indeed, the ability to estimate quantities immediately, present in man and in a number of animals, is probably due to such an intensive process of quantification. A mind quantifying in a purely intensive manner would carry out some operations more simply and immediately than our mathematics of the "dredging-scoop" variety. For example, it might be able to calculate curves immediately, which is possible in our extensive mathematics only by means of the detour of integral and differential calculus, a detour which tides us over the limitations of the numerical steps, but still clings to them conceptually. An intellect quantifying purely by intensity would not be able to grasp that two times two equals four. Since it would have no understanding for the number one, for our empty numerical box, it would also not comprehend our postulate of the equality of two such boxes and would reply to our arrangement of an equation that it is incorrect because no equal boxes, rams, or atoms exist. And in regard to its system, it would be just as correct in its statement as we would be in ours. Certainly an intensive quantification system would perform many operations more poorly, that is, in a more involved manner, than does numerical mathematics. The fact that the latter has developed so much further than the ability of intensive quantitative estimation speaks for its being the more "practical" one. But even so it is and remains only an organ, an evolutionarily acquired, "innate working hypothesis" which basically is only approximately adapted to the data of the thing-in-itself.

If a biologist attempts to grasp the relationship of hereditary structure to the regulated plasticity of all that is organic, he arrives at a universal law holding both for physical and intellectual structures and as valid for the

plastic protoplasm and the skeletal elements of a protozoan as for the categorical forms of thought and the creative plasticity of the human mind. From its simplest beginnings in the domain of the protozoa, solid structure is just as much a condition for any higher evolution as is organic plasticity. In this sense, solid structure is just as indispensable and as consistent a property of living matter as is its plastic freedom. However, every solid structure, although indispensable as a support for the organic system, carries with it an undesired side effect: it makes for rigidity, and takes away a certain degree of freedom from the system. Every enlistment of a mechanical structure means in some sense to bind oneself. Von Uexkuell has said aptly: "The amoeba is less of a machine than the horse," thinking mainly about physical properties. Nietzsche has expressed poetically the same relationship between structure and plasticity in human thought: ". . . a thought—Now still hot liquid lava, but all lava builds a castle around itself. Every thought finally crushes itself with 'laws'." This simile of a structure crystallizing out of the liquid state goes much deeper than Nietzsche sensed: It is not entirely impossible that all that becomes solid, in the intellectual-psychic as well as in the physical, is bound to be a transition from the liquid state of certain plasma parts to the solid state.

But Nietzsche's simile and Uexkuell's statement overlook something. The horse is a higher animal than the amoeba not despite, but to a large extent because of its being richer in solid differentiated structures. Organisms with as few structures as possible must remain amoebae, whether they like it or not, for without any solid structure all higher organization is inconceivable. One could symbolize organisms with a maximum of highly differentiated fixed structures as lobsters, stiffly armored creatures which could move only in certain joints with precisely allowed degrees of freedom or as railroad cars which could only move along a prescribed track having very few switching points. For every living being, increasing mental and physical differentiation is always a compromise between these two

extremes, neither one representing the highest realization of the possibilities of organic creation. Always and everywhere differentiation to a higher level of mechanical structure has the dangerous tendency to fetter the mind, whose servant it was just a moment ago, and to prevent its further evolution. The hard exoskeleton of the arthropods is such an obstruction in evolution, as is also the fixed instinctual movements of many higher organisms and the industrial machinery of man.

Indeed, every system of thought that commits itself to a nonplastic "absolute" has this same fettering effect. The moment such a system is finished, when it has disciples who believe in its perfection, it is already "false." Only in the state of becoming is the philosopher a human being in the most proper meaning of the word. I am reminded of the beautiful definition of man which we owe to the pragmatist and which probably is given in its clearest formulation in Gehlen's book *Der Mensch*. Man is defined as the permanently unfinished being, permanently unadapted and poor in structure, but continuously open to the world, continuously in the state of becoming.

When the human thinker, be it even the greatest, has finished his system, he has in a fundamental way taken on something of the properties of the lobster or the railroad car. However ingeniously his disciples may manipulate the prescribed and permitted degrees of freedom of his lobster-armor, his system will only be a blessing for the progress of human thought and knowledge when he finds not "built in," degrees of freedom, turn its pieces into a new construction. If, however, a system of thought is so well joined together that for a long time no one appears who has the power and the courage to burst it asunder, it can obstruct progress for centuries: "There lies the stone, one has to let it be, and everyone limps on his crutch of faith to devil's stone, to devil's bridge" (*Goethe, Faust*).

And just as a system of thought created by the individual human being enslaves its creator, so also do the evolutionarily developed supra-individual forms of thought of the a

priori: They, too, are held to be absolute! The machine whose species-preserving meaning was originally in quantifying real external things, the machine that was created for "counting rams" suddenly pretends to be absolute and buzzes with an admirable absence of internal friction and contradiction, but only as long as it runs empty, counting its own shovels. If one lets a dredging-machine, an engine, a band saw, a theory, or an a priori function of thought run empty in this way, then its function proceeds *ipso facto* without noticeable friction, heat, or noise; for the parts in such a system do not, of course, contradict one another and so fit together intelligibly and in a well-tuned manner. When empty they are indeed "absolute," but absolutely empty. Only when the system is expected to work, that is, to achieve something in relation to the external world in which the real and species-preserving meaning of its whole existence does indeed consist, then the thing starts to groan and crack: when the shovels of the dredging-machine dig into the soil, the teeth of the band saw dig into the wood, or the assumptions of the theory dig into the material of empirical facts which is to be classified, then develop the undesirable side-noises that come from the inevitable imperfection of every naturally developed system: *and no other systems exist for the natural scientist*. But these noises are just what does indeed represent the coping of the system with the real external world. In this sense they are the door through which the thing-in-itself peeps into our world of phenomena, the door through which the road to further knowledge continues to lead. They, and not the unresisting empty humming of the apparatus, are "reality." They are, indeed, what we have to place under the magnifying glass if we want to get to know the imperfections of our apparatus of thought and experience and if we want to gain knowledge beyond these imperfections. The side-noises have to be considered methodically if the machine is to be improved. The fundamentals of pure reason are just as imperfect and down to earth as the band saw, but also just as real.

Our working hypothesis should read as follows: Everything is a working hypothesis. This holds true not only for the natural laws which we gain through individual abstraction *a posteriori* from the facts of our experience, but also for the laws of pure reason. The faculty of understanding does not in itself constitute an explanation of phenomena, but the fact that it projects phenomena for us in a practically usable form on to the projection-screen of our experiencing is due to its formulation of working hypotheses, developed in evolution and tested through millions of years. Santayana says: "Faith in the intellect is the only faith that has justified itself by the fruit it has borne. But the one who clings forever to the form of faith is a Don Quixote, rattling with outmoded armor. I am a decided materialist with regard to natural philosophy, but I do not claim to know what matter is. I am waiting for the men of science to tell me that."

Our view that all human thought is only a working hypothesis must not be interpreted as lowering the value of the knowledge secured by mankind. It is true that this knowledge is only a working hypothesis for us, it is true that we are ready at any moment to throw overboard our favorite theories when new facts demand this. But even if nothing is "absolutely true," every new piece of knowledge, every new truth, is nevertheless a step forward in a very definite, definable direction: the absolutely existent is apprehended from a new, up to this point unknown, aspect; it is covered in a new characteristic. For us that working hypothesis is true which paves the way for the next step in knowledge or which at least does not obstruct the way. Human science must act like a scaffolding for reaching the greatest possible height, without its absolute extent being foreseeable at the start of the construction. At the moment when such a construction is committed to a permanently set supporting pillar, the latter fits only a building of a certain form and size. Once these are reached and the building is to continue, the supporting pillar has to be demolished and rebuilt, a process which can become the more dangerous for the entire structure, the more deeply

that which is to be rebuilt is set in its foundation. Since it is a constituent property of all true science that its structure should continue to grow into the boundless, all that is mechanically systematic, all that corresponds to solid structures and scaffolding, must always be something provisional, alterable at any time. The tendency to secure one's own building for the future by declaring it absolute leads to the opposite of the intended success: Just that "truth" which is dogmatically believed in, sooner or later leads to a revolution in which the actual truth-content and value of the old theory are all too easily demolished and forgotten along with the obsolete obstructions to progress. The heavy cultural losses which may accompany revolutions are special cases of this phenomenon. The character of all truths as working hypotheses must always be kept in mind, in order to prevent the necessity of demolishing the established structure, and in order to preserve for the "established" truths, that eternal value which they potentially deserve.

Our conception that *a priori* forms of thought and intuition have to be understood just as any other organic adaptation carries with it the fact that they are for us "inherited working hypotheses," so to speak, whose truth-content is related to the absolutely existent in the same manner as that of ordinary working hypotheses which have proven themselves just as splendidly adequate in coping with the external world. This conception, it is true, destroys our faith in the absolute truth of any *a priori* thesis necessary for thought. On the other hand it gives the conviction that something actual "adequately corresponds" to every phenomenon in our world. Even the smallest detail of the world of phenomena "mirrored" for us by the innate working hypotheses of our forms of intuition and thought is in fact pre-formed to the phenomenon it reproduces, having a relationship corresponding to the one existing between organic structures and the external world in general (e.g., the analogy of the fin of the fish and the hoof of the horse, above). It is true that the *a priori* is only a box whose form unpretentiously fits

that of the actuality to be portrayed. This box, however, is accessible to our investigation even if we cannot comprehend the thing-in-itself except by means of the box. But access to the laws of the box, i.e., of the instrument, makes the thing-in-itself relatively comprehensible.

Now what we are planning to do in patient empirical research work is an investigation of the "a priori," of the "innate" working hypotheses present in subhuman organisms. This includes species that achieve a correspondence to the properties of the thing-in-itself less detailed than that of man. With all their incredible accuracy of aim, the innate schematisms of animals are still much more simple, of coarser screen, than those of man, so that the boundaries of their achievement still fall within the measurable domain of our own receptive apparatus. Let us take as analogy the domain that can be resolved with the lens of a microscope: the fineness of the smallest structure of the object still visible with it is dependent upon the relationship between angle of aperture and focal length, the so-called "numerical aperture." The first diffraction spectrum which is thrown by the structural grating must still fall into the front lens in order that the grating is seen as such. If this is no longer the case, one does not see the structure; rather, the object appears with a smooth surface and, strangely enough, brown.

Now let us suppose I had only one microscope. Then I would say structures are only "conceivable" up to that fineness, finer ones do not exist. Moreover, though I would have no reason to assume that this color has the slightest relationship to the visible structures. However, if one also knew of less strongly resolving lenses which register "brown" for structures which are still visible as structures by our instruments, then one would be very skeptical toward our instrument's registering brown (unless one had become a megalomaniac and pronounced one's own receptive apparatus absolute, just for the reason that it was one's own property). If one is more modest, however, one will draw the right conclu-

sion from the comparison of the limits of achievement and the fact that the various instruments register brown. The conclusion is that even the most powerful lenses have limits as to the fineness of structure resolved, just as do simpler apparatuses. In a methodically similar way one can learn much from the functional limitations which the various apparatuses for organizing the image of the universe all have. The lesson so learned provides an important critical perspective for judging the limits of achievement of the highest existing apparatus, which today cannot be investigated from the observation tower of a still higher one.

Looking at it from a physiological viewpoint, it is self-evident that our neural apparatus for organizing the image of the world is basically like a photoprint screen which cannot reproduce any finer points of the thing-in-itself than those corresponding to the numerically finite elements of the screen. Just as the grain of the photographic negative permits no image originating from unlimited enlargement, so also there are limitations in the image of the universe traced out by our sense organs and cognitive apparatus. These too permit no unlimited "enlargement," no unlimited view of details, however self-evident and real the image may appear at superficial inspection. Where the physical image of the universe formed by man has advanced to the atomic level, there emerge inaccuracies in the coordination between the a priori "necessities of thought" and the empirically actual. It is as though the "measures of all things" was simply too coarse and too approximate for these finer spheres of measurement, and would only agree in general and at a statistical-probabilistic level with that which is to be comprehended of the thing-in-itself. This is increasingly true for atomic physics, whose entirely impalpable ideas can no longer be experienced directly. For we can only "spell-out as experience" in a directly experienceable manner (to apply Kant's own expression to this physiological fact) that which can be written on the crudely simplifying "keyboard" of our central nervous system. But in different

organisms, this keyboard can be differentiated in a more simple or more complex manner. To represent it by the analogy of the photoprint screen, the best possible picture that can be reproduced by an apparatus of a given degree of fineness corresponds to those representations encountered in cross-stitch embroideries which build round-contoured animals and flowers from small rectangular elements. The property of "being composed of squares" does in no way belong to the represented thing-in-itself, but is due to a peculiarity of the picture apparatus, a peculiarity which can be regarded as a technically unavoidable limitation. Similar limitations accompany each apparatus for organizing the image of the world, if only because of its being composed of cellular elements (as is the case for vision). Now if one examines methodically what the cross-stitch representation permits to be stated about the form of the thing-in-itself, the conclusion is that the accuracy of the statement is dependent upon the relationship between the size of the picture and the grain of the screen. If one square is out of line with a straight-line contour in the embroidery, one knows that behind it lies an actual projection of the represented thing, but one is not sure whether it exactly fills the whole square of the screen or only the smallest part of it. This question can be decided only with the help of the next finest screen. But behind every detail which even the crudest screen reproduces there certainly lies something real, simply because otherwise the respective screen-unit would not have registered. But no tool is at our disposal to determine what lies behind the registering of the finest existent screen-unit, whether much or little of the contour of that which is to be reproduced protrudes into its domain. The fundamental indiscernibility of the last detail of the thing-in-itself remains. We are only convinced that all details which our apparatus does reproduce correspond to actual attributes of the thing-in-itself. One becomes more and more firmly convinced of this entirely real and lawful correlation between the Real and the Apparent, the more one con-

cerns oneself with the comparison of apparatuses for organizing the image of the world of animals as different from one another as possible. The continuity of the thing-in-itself, most convincingly emerging from such comparisons, is completely incompatible with the supposition of an alogical, extrinsically determined relationship between the thing-in-itself and its appearances.

Such comparative research brings us closer to the actual world lying behind the phenomena, providing we succeed in showing that the different a priori formations of possible reaction (and thus of possible experience) of the different species make experienceable the same lawfulness of real existents and lead to its control in a species-preserving way. Such different adaptations to one and the same lawfulness strengthen our belief in its reality in the same manner as a judge's belief in the actuality of an event is strengthened by several mutually independent witnesses giving descriptions of it that are in general agreement, though not identical. Organisms that are on a much lower mental level than man struggle quite evidently with the same data that are made experienceable in our world by the forms of perception of space and time and by the category of causality; but they do it by means of quite different and much simpler achievements, which are accessible to scientific analysis. Even if the a priori human forms of perception and thought remain inaccessible to causal analysis for the time being, we as natural scientists must nevertheless desist from explaining the existence of the a priori (or in general of pure reason) by a principle extraneous to nature. We must instead regard any such explanatory attempt as a completely arbitrary and dogmatic division between the rationally comprehensible and the unknowable, a division which has done as serious damage in obstructing research, as have the prohibitions of the vitalists.

The method to be used can be explained, by analogy to the microscope, as a science of apparatuses. Basically, we can comprehend only the lower precursors of our own forms of perception and thought. Only where laws

represented through these primitive organs can be identified with those represented on our own apparatus can we clarify properties of the human *a priori*, using the more primitive as a starting point. In this way we can draw conclusions about the continuity of the world lying behind phenomena. Such an enterprise succeeds quite well compared with the theory of the *a priori* forms of perception of space and the category of causality. A large number of animals do not comprehend the "spatial" structurization of the world in the same way we do. We can, however, have an approximate idea what the "spatial" looks like in the world-picture of such organisms because in addition to our spatial apprehension we also possess the ability to master spatial problems in their manner. Most reptiles, birds, and lower mammals do not master problems of space as we do through a simultaneous clear survey over the data. Instead, spatial problems are learned by rote. For example, a water shrew when placed into new surroundings gradually learns by rote all possible paths by slow crawling about, constantly guided by sniffing and feeling with the whiskers in such a manner as perhaps a child learns piano pieces by rote. In the laborious piecemeal sequence of limb movements first short stretches become "known movements," followed by a smoother linking of these parts. And these movements, smoothing and steadying themselves by becoming kinesthetically ingrained, extend farther and farther and finally flow together into an inseparable whole which, running off fast and smoothly, has no longer any similarity with the original search movements. These sequences of movement, so laboriously acquired, and run-off so extraordinarily fast and smoothly, do not take the "shortest way." On the contrary, chance determines what spatial pattern such a path learning takes. It even happens that the winding path intersects itself, without the animal necessarily noticing how the end of the path can be brought closer by cutting off the superfluous piece.⁴

For an animal, like the water shrew, that masters its living space almost exclusively by path learning, the thesis is by no means valid

that the straight line is the shortest connection between two points. If it wanted to steer in a straight line (which lies basically within its abilities) it would constantly have to approach its goal sniffing, feeling with its whiskers and using its eyes, which are not very efficient. In this process it would use up more time and energy than by going the path it knows by rote. If two points which on this path lie quite far apart are spatially close together, the animal knows it not. Even a human being can behave in this way, for example, in a strange city. It is true, however, that under such circumstance we humans succeed sooner or later in getting a spatial survey which opens up the possibility of a straight-line short cut for us. The sewer rat, which is on a much higher mental level than the shrew, likewise soon finds short cuts. The greylag goose could, as we have seen, achieve the same thing, but does not do it for religious reasons, as it were; it is prevented by that peculiar inhibition which also ties primitive people so much to habit. The biological meaning of this rigid clinging to "tradition" is easily understandable: it will always be advisable for an organism that does not have at its disposal a spatial-temporal-causal survey over a certain situation to persist rigidly in the behavior that has proved successful and free of danger. So-called magical thought, by no means present only in primitive people, is closely related to this phenomenon. One need only think of the well-known "knock on wood." The motive that "after all, one cannot tell what is going to happen if one omits doing it" is very clear.

For the true kinesthetic creature, such as the water shrew, it is literally impossible as far as its thinking is concerned to find a short cut. Perhaps it learns one when forced by external circumstances, but again only by learning by rote, this time a new path. Otherwise there is an impenetrable wall for the water shrew between two loops of its path, even when they almost or actually touch. How many such new possibilities of solution, in principle equally simple, we humans may overlook with equal blindness in the struggle with our daily problems! This thought obtrudes itself with com-

pelling force upon anyone who in his direct daily associations with animals has come to know their many human characteristics and at the same time the fixed limits to their achievement. Nothing can be more apt to make the scientist doubt his own God-like character, and to inculcate in him a very beneficial modesty.

From a psychological viewpoint, the water shrew's command of space is a sequence of conditioned reflexes and kinesthetically ingrained movements. It reacts to the known steering marks of its path with conditioned reflexes which are less a steering than a control to ascertain that it is still on the right path, for the kinesthetic movement known by rote is so precise and exact that the process takes place almost without optical or tactile steering, as in the case of a good piano player who need hardly look at the score or the keys. This sequence formation of conditioned reflexes and known movements is by no means only a spatial but also a spatial-temporal formation. It can be produced only in one direction. To run the course backward requires completely different trainings. To run the paths learned by rote the wrong way is just as impossible as to recite the alphabet in the wrong sequence. If one interrupts the animal running along its trained path, taking away a hurdle that has to be jumped, it becomes disoriented and tries to reconnect the chain of the ingrained links at an earlier place. Therefore it runs back searches until it becomes re-oriented in the signs of its path and tries again. Just like a little girl that has been interrupted in reciting a poem.

A relationship very similar to the one we find between the disposition toward learning paths by rote and the human form of perception of space exists between the disposition toward developing conditioned reflexes (associations), and the human category of causality. The organism learns that a certain stimulus, for example, the appearance of the keeper, always precedes a biologically relevant event, let us say, feeding; it "associates" these two events and treats the first as the signal for the occurrence of the second one by starting

preparatory reactions upon the onset of the first stimulus (e.g., the salivation reflex investigated by Pavlov). This connection of an experience with the regularly followed post hoc is totally unrelated to causal thought. It should be remembered that, for example, kidney secretion, a completely unconscious process, can be trained to conditioned reflexes! The reason why post hoc was still equated with and mistaken for propter hoc is that the disposition for association and causal thought actually achieve the same thing biologically; they are, so to speak, organs for coping with the same real datum.

This datum is without any doubt the natural lawfulness contained in a major thesis of physics. The "conditioned reflex" arises when a certain outer stimulus, which is meaningless for the organism as such, is followed several times by another, biologically meaningful one, that is, one releasing a reaction. The animal from now on behaves "as if" the first stimulus were a sure signal preceding the biologically significant event that is to be expected. This behavior obviously has a species-preserving meaning only if in the framework of the real a connection between the first, the "conditioned" and the second, the "unconditioned" stimulus, exists. A lawful temporal sequence of different events regularly occurs in nature only where a certain quantity of energy appears sequentially in different phenomenal forms through transformation of force. Thus connection in itself means "causal connection." The conditioned reflex "advocates the hypothesis" that two stimuli, occurring several times in a certain sequence, are phenomenal forms of the same quantity of energy. Were this supposition false and the repeated sequence conditioning the association of the stimuli only a purely accidental one, a probably never returning "post hoc," then the development of the conditioned reaction would be a dysteleological failure of achievement on the part of a disposition which is generally and probabilistically meaningful, in the sense of being species-preserving.

Since we are today ignorant of its physiological foundations, we can examine the category

of causality only through critical epistemology. In its biological function, it is an organ for comprehending the same natural lawfulness aimed at by the disposition to acquire conditioned reflexes. We cannot define the concept of cause and effect in any other way than by determining that the effect receives energy from the cause in some form or other. The essence of "propter hoc" which alone differentiates it qualitatively from a "uniform post hoc" lies in the fact that cause and effect are successive links in the infinite chain of phenomenal forms that energy assumes in the course of its everlasting existence.

In the case of the category of causality, the attempt to explain it as a secondary abstraction from preceding experience (in Wundt's sense) is instructive. If one attempts this, one always arrives at the definition of a "regular post hoc," but never at that highly specific quality which lies a priori in every sensible use of "why" and "because" even by a little child. One cannot expect a child to have the ability to comprehend abstractly a fact which was not stated in an objective, i.e., purely physical form until 1842, by J. R. Mayer. Joule, in a lecture given in 1847 (*On Matter, Living Force and Heat*, London 1884, p. 265) declared in a surprisingly simple manner that it is "absurd" to assume living force could be destroyed without in some way restoring something equivalent. The great physicist thus quite naïvely takes the point of view of critical epistemology. It would be a highly interesting question, from the point of view of the history of ideas, whether in his discovery of the equivalent of heat he started with the a priori "un-thinkableness" of the destruction and creation of energy, as it would appear, judging by his above remark. It does not fit into our concept of cause and effect that the a priori category of causality is actually based upon nothing but the inevitable sequence of two events and that it can happen that the event occurring later in time does not draw its energy from the preceding one, but that both are mutually independent side-chains of a branching chain of causality. The case can arise that an event regularly has two effects, of which one occurs

faster than the other, thus always preceding it in experience. Thus lightning follows electrical discharge more quickly than thunder. Nevertheless, the optical phenomenon is by no means the cause of the acoustic one! Perhaps one may object here that this consideration is hairsplitting, and for many naïve people lightning still is the cause for thunder. But the hairsplitting frees us from a primitive conception and moves us one step closer to the real connection of things. Mankind today lives by the function of the innate category of causality.

We shall now examine methodologically the functionally analogous achievements of animals from the higher observation tower of human form of perception of space and category of causality; first, the disposition to kinesthetic learning by rote of paths, and then the disposition to blind association of sequential events. Is it "true" what the water shrew "knows" about the spatial? In the water shrew's case, learning creates an "ordo et connectio idearum," also visible in our image of the universe: namely, the condition that places and locomotive parts are strung like a row of pearls. The water shrew's orderly scheme is entirely correct—as far as it reaches! In our perception the string of pearls is visible, too; the sequence of the links is true. Only for us there exists (and are true) an immense number of further data which the shrew lacks: for example, the possibility to short-cut the loops of a path. Also from a pragmatic point of view, our perception is true to a higher degree than is the animal's image of the universe.

Something very similar results when we compare the disposition to association with our causal thought: here, too, the lower, more primitive rendering by the animal gives a connection between the events which exists also for our form of thought: the temporal relationship between cause and effect. The deeper actuality, essential to our causal thought, that energy is received from the cause by the effect is not given to purely associative thought. Here, too, then the lower form of thought corresponds a priori and adequately to the reality

of a higher order, but again only as far as it reaches. Here, too, human form of thought is more true from the pragmatist's point of view; think of all it achieves that cannot be achieved by pure association! As I have said, we all live by the work of this important organ, almost as by the work of our hands.

With all the emphasis on these differences in the degree of correspondence between image of the universe and actuality, we must not forget for one moment that something real is reflected even in the most primitive "screens" of the apparatuses for organizing the image of the universe. It is important to emphasize this because we humans likewise use such apparatuses even though they may be very different. Progress in science always has a certain tendency to de-anthropomorphize our image of the universe, as Bertalanffy has correctly pointed out. From the palpable and sensible phenomenon of light, the impalpable, unvisualizable concept of wave phenomena has developed. The self-evident comprehension of causality is replaced by considerations of probability and arithmetic calculations, etc. One can actually say that among our forms of perception and categories there are "more anthropomorphic" ones and "less anthropomorphic" ones; or some that are more specialized and others that are more general. Doubtless a rational being lacking the sense of vision could comprehend the wave theory of light, while not comprehending specifically human perceptual experience. Looking beyond specifically human structures, as is done to the highest degree in mathematical science, must not lead to the view that the less anthropomorphic representations approach a higher degree of actuality, that is, that they approach the thing-in-itself more closely than does native perception. The more primitive reproduction has just as real a relationship to the absolutely existent as does the higher one. Thus, the animal's apparatus for organizing the image of the universe reproduces only one detail, and in a purely associative manner, from the actuality of the transformation of energy, namely, that a certain event precedes another one in time. But one can in no way

assert that the statement "a cause precedes an effect" is less true than the statement that an effect arises from the preceding phenomenon through transformation of energy. The advance from the more simple to the more differentiated lies in the fact that additional, new definitions are added to those already existing. If in such an advance from a more primitive reproduction of the universe to a higher one certain data which are represented in the first are neglected in the second, then it is only a question of change in point of view, and not a matter of a closer approach to the absolutely existent. The most primitive reactions of the protozoa reflect an aspect of the world to which all organisms must similarly relate, just as much as do the calculations of a *Homo sapiens* who studies theoretical physics. But we can no more ascertain how much exists in absolute actuality in addition to the facts and relationships rendered in our image of the universe than the water shrew can ascertain that it could shortcut many detours in its crooked path learning.

With regard to the absolute validity of our "necessities of thought" we are accordingly modest: We believe only that in some details they correspond more to the actually existent than do those of the water shrew. Above all, we are conscious of the fact that we surely are just as blind in regard to as many additional things as that animal is: that we too are lacking the receptive organs for infinitely much that is actual. The forms of perception and categories are not the mind, but rather are tools the mind uses. They are innate structures that on the one hand support, but on the other hand make for rigidity like all that is solid, Kant's great conception of the idea of freedom, namely that the thinking being is responsible to the totality of the universe, suffers from the ailment of being chained to the rigidly mechanical laws of pure reason. The *a priori* and the preformed ways of thought are just the ones that are by no means specifically human as such. Specifically human, however, is the conscious drive not to get stuck, not to become a vehicle running on rails, but rather to maintain a youthful openness to the world,

and to come closer to actuality through a constant reciprocal interaction with it.

Being biologists, we are modest regarding man's position in the totality of nature, but more demanding in regard to what the future may yet bring us in the way of knowledge. To declare man absolute, to assert that any imaginable rational being, even angels, would have to be limited to the laws of thought of *Homo sapiens*, appears to us to be incomprehensible arrogance. For the lost illusion of a unique lawfulness for man, we exchange the conviction that in his openness to the world he is basically capable of outgrowing his science and the a priori formulations of his thought, and of creating and realizing basically new things that have never existed before. To the extent he remains inspired by the will not to let every new thought be choked by the cover of the laws crystallizing around it, in the fashion of Nietzsche's drops of lava, this development will not so soon encounter any essential obstacle. In this lies our concept of freedom; it is the greatness, and, at least on our planet the provisional uniqueness of our human brain that, in spite of all its gigantic differentiation and structurization, it is an organ whose function possesses a proteus-like changeability, a lava-like capacity to rise against the functional restrictions imposed on it by its own structure, to the point where it achieves a flexibility even greater than that of protoplasm-lacking solid structures.

What would Kant say about all this? Would he feel that our naturalistic interpretation of human reason (for him, supernaturally given) is desecration of the most sacred? (This it is in the eyes of most neo-Kantians.) Or would he, in view of his own occasional approaches to evolutionary thought, have accepted our conception that organic nature is not something amoral and Godforsaken, but is basically "sacred," in its creative evolutionary achievements, especially in those highest achievements, human reason and human morals? We are inclined to believe this, because we believe that science could never destroy a deity, but person who reproaches us with lacking re-

spect for the greatness of our philosopher we counter by quoting Kant himself: "If one starts with an idea founded but not realized and bequeathed to us by another, by continual thinking one can hope to progress further than did the ingenious man to whom one owed the spark of this light." The discovery of the a priori is that spark we owe to Kant and it is surely not arrogance on our part to criticize the interpretation of the discovery by means of new facts (as we did in criticizing Kant with regard to the origin of the forms of perception and categories). This critique does not lower the value of the discovery any more than it lowers that of the discoverer. To anyone, following the erroneous principle "*Omnis naturalia sunt turpia*," who persists in seeing a desecration in our attempt to look at human reason naturalistically we counter by again quoting Kant himself: "When we speak of the totality of nature, we must inevitably conclude that there is Divine regulation. But in each phase of nature" (since none are at first given simply in our sensory world) "we have the obligation to search for underlying causes, in so far as possible, and to pursue the causal chain, so long as it hangs together, according to laws that are known to us."

NOTES

1. Translated from: Kant's *Lehre vom apriorischen im Lichte gegenwärtiger Biologie. Blätter für Deutsche Philosophie*, 1941, 94-125. This rough translation has been prepared by Charlotte Ghurye and edited by Donald T. Campbell with the assistance of Professor Lorenz and William A. Reupke. Ghurye, Lorenz, and Reupke have not had an opportunity to see the translation in present form. While the translation is still very uneven, there is one naïveté of wording which represents a deliberate avoiding of some more sophisticated usages. The hyphenated phrase 'thing-in-itself' has been used as a translation for the Kantian phrases "Ding an sich," "An sich Seienden," "An sich Bestehenden," "An sich der Dinge," An sich existenden Natur," etc. This has seemed preferable here to the usual usage of leaving the phrase untranslated, or of translating it into the Greek "noumena." To preserve some Kantian distinctions even at the ex-

pense of awkward renditions, these equivalents have been used: Wahrnehmung=perception; Anschauung=intuition; Realität=reality; Wirklichkeit=actuality; Gegenstand=object; Ding=thing.

2. Prolegomena, First Part, note III. The present translators have used here the translation of Kant provided by P. G. Lucas, Manchester University Press, 1953.

3. Translation of P. G. Lucas, Manchester University Press, 1953.

4. Rats and other mammals that are on a higher mental level than the water shrew notice such possibilities of a short cut immediately. I experienced a highly interesting case with a greylag goose in which the possibility of a short cut in path learning was undoubtedly noticed, but not made use of. When a gosling, this bird had acquired a path learning which led through the door of our house and up two flights of a wide staircase to my room, where the goose used to spend the night. In the morning it used to make its exit by flying through the window. When learning the path, the young greylag goose ran first of all toward a large window in the yet strange staircase, past the lowest step. Many birds, when disquieted, strive for the light, and so this goose, too, decided to leave the window and come to the landing to which I had wanted to lead it only after it had quieted down a little. This detour to the window remained once and for all an indispensable part of the path learning which the greylag goose had to go through on its way to the

place where it used to sleep. This very steep detour to the window and back gave a very mechanical effect, almost like a habitually performed ceremony, because its original motivation (anxiety and therefore shying away from the darkness) was no longer present. In the course of this goose's path learning, which took almost two years, the detour became gradually leveled off, that is, the line originally going almost as far as the window and back had now sloped down to an acute angle by which the goose deflected its course toward the window and mounted the lowest step at the extremity facing the window. This leveling off of the unnecessary would probably have led to attaining the actually shortest way in two more years and had nothing to do with insight. But a goose is, properly speaking, basically capable of finding such a simple solution by insight; though habit prevails over insight or prevents it. One evening the following happened. I had forgotten to let the goose into the house, and when I finally remembered, it was standing impatiently on the door step and rushed past me and—to my great surprise—for the first time took the shortest way and up the stairs. But already on the third step it stopped, stretched its neck, uttered the warning cry, turned around, walked the three steps down again, made the detour to the window hastily and "formally" and then mounted the stairs calmly in the usual way. Here obviously the possibility of a solution by insight was blocked only by the existence of that learned by training!

MICHAEL RUSE

The View from Somewhere: A Critical Defense of Evolutionary Epistemology ~

Charles Robert Darwin, the father of modern evolutionary theory, hit upon his mechanism of evolution through natural selection somewhere towards the end of September 1838 (Ruse 1979a; Ospovat 1981). At once, he started to think of its possible applications to our own species. Indeed, the very first explicit writings on selection that we have in Darwin's private notebooks, occurring around the end of October 1838, consider possible implications of the mechanism for human thought processes. However, when Darwin finally published his

evolutionary speculations in *On the Origin of Species* in 1859, he said little about our own species, simply noting that his general views would have specific applications for *Homo sapiens*.

This silence was not cowardice. Darwin never wanted to conceal the implications of his ideas, but he was concerned first to make as full a case as he could for the general theory. Finally, in 1871, Darwin turned to human beings in their own right and accorded them detailed treatment in his *The Descent of Man*.